Spinning liquid crystal tuneable laser prototype system for biomedical microscopy applications

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Liquid crystal lasers have many advantages over traditional coherent light sources *[1]*: Their self-organsing chiral nanostructure provides a simple and inexpensive tuneable resonant cavity; the wide available range of soluble organic dyes provide a broad and continuous tuning range across the visible spectrum and beyond; they are capable of extremely high slope-efficiencies (up to 60%) *[2]*; they can be tailored to emit highly customisable light fields, including multiple simultaneous polychromatic emissions *[3]*; and they can painted or printed onto surfaces *[4,5]*. Unfortunately, despite these unique and advantageous features, liquid crystal lasers have so far failed to reach any commercial application as a light source. Many of the advances in liquid crystal laser technology have been demonstrated independently to each other, using specialist laboratory facilities. Limitations in the maximum stable average power (typically < 1 mW) have also restricted their applications. Power is limited prinicpally by repetition rate, typically < 200 Hz. Higher repetition rates lead to triplet state generation, optical fatigue, and a subsequent reduction in lasing efficiency and stability.

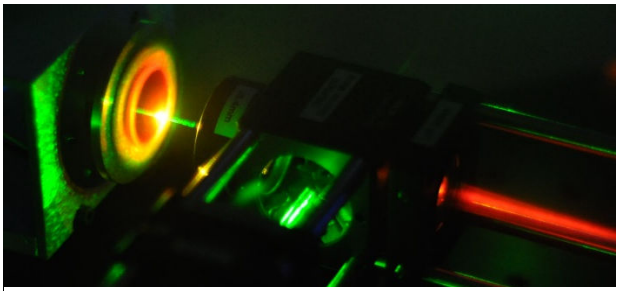

Fig.1: Spinning liquid crystal laser (left), capable of stable higher average power emission (red).

In this paper, we report on new advances in spinning liquid crystal lasers, which enable stable high repetition rate lasing (> 5 kHz) and a corresponding increase in average power output of more than an order of magnitude compared to static systems. We also report on the development of a portable high-performance liquid crystal laser prototype system, capable of tunable wavelength emission between 450 and 850 nm at these increased optical powers, and the generation of rapidly-switching (~ ms) wavelength sequences. This digitally-controlled benchtop tuneable laser system, is being developed to demonstrate new capabilities in advanced biomedical microscopy techniques, and acts as a prototype test-bed for potential future commercialisation activities.

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